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Bio-Isolated DC Operational Amplifier

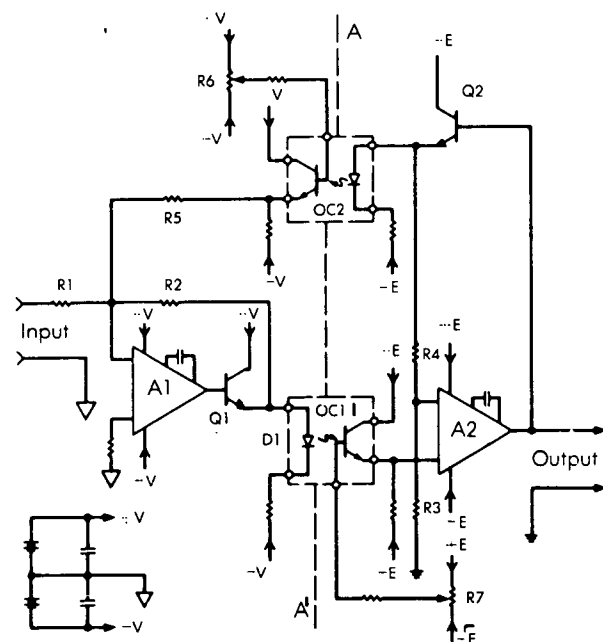
The amplification of bioelectrical potentials obtained from catheterized patients is always attendant with the possibility of electrical shock, for if line-operated amplifying systems have ground leakage

at low levels and the DC input signals are restored at the demodulator output. Either amplitude- or FM-modulation techniques are used for transmitting the DC information.

The isolated amplifier circuit shown in the diagram consists of a battery-powered operational amplifier coupled by means of light-emitting diodes to another amplifier in the right of the line A-A' which may be grounded and operated from AC power mains or a separate battery supply. The important feature of this arrangement is that the circuit and its ground on the left of line A-A' is completely separate from the circuit and the ground on the right side of the line.

Bio signals from ECG, EEG, or other analog monitoring instruments are applied to the input of operational amplifier A1, the gain of which is determined by the ratio of R1 and R2. If A1 does not have sufficient power to operate the light-emitting diode D1 in the optic coupler assembly OC1, amplifier Q1 is included in the circuit as shown (with amplifiers of sufficient power, the overall device is quite simple). The amount of light emitted by diode D1 is proportional to the signal fed to the amplifier A1.

The optic coupler OC1 provides an isolation resistance of about 10^{11} ohms with a coupling capacitance of about 1.5 pf; the coupler consists of the light-emitting diode attached to the output of A1 and a phototransistor which is in the input circuit of a non-inverting operational amplifier A2. The gain of amplifier A2 is set by the ratio of R3 and R4 along with Q2. Amplifier Q2 drives the light-emitting diode in optic coupler OC2; the system operates to couple a DC feedback signal from amplifier A2 to the phototransistor detector in OC2. The output of OC2 is coupled through resistor R5 to the input of amplifier A1, thus controlling the gain of A1. Resistor R6 provides DC bias to the detector of OC2 and serves to



currents as low as 20 microamperes, ventricular fibrillation can set in and be fatal unless corrected within minutes. The shock pathway generally involves the patient ground traditionally connected to a local powerline or earth ground.

The possibility of occurrence of shocks from leakage currents can be reduced by the use of isolated preamplifiers. Prior methods for achieving isolation usually involved transformers in DC-to-DC converter circuits, for example, an input preamplifier driving a low-level modulator-transformer or light coupler-demodulator at a given frequency; the isolation occurs

(continued overleaf)

balance A1 to a DC zero so that signals are not distorted; similarly, R7 is used to balance A2.

Note:

No additional documentation is available. Specific questions, however, may be directed to:

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Reference: TSP 74-10112

Patent status:

This invention has been patented by NASA (U.S.

Patent No. 3,811,094). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to:

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